BIOLOGICAL INTEGRITY OF STREAMS IN THE BIG HOLE RIVER TMDL PLANNING AREA BASED ON THE STRUCTURE AND COMPOSITION OF THE BENTHIC ALGAE COMMUNITY

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Summary

In the summer of 2003, periphyton samples were collected from 42 sites on 22 streams in the Big Hole River TMDL planning area in southwestern Montana for the purpose of assessing whether these streams are water-quality limited and in need of TMDLs. The samples were collected following MDEQ standard operating procedures, processed and analyzed following standard methods for periphyton, and evaluated following modified USEPA rapid bioassessment protocols for wadeable streams.

Diatom metrics indicate minor impairment from both organic loading and sedimentation at most of the sites that were sampled for periphyton. However, the pollution index at one site—**Swamp Creek site 01**—indicated **moderate impairment** from excessive organic nutrients and only partial support of aquatic life uses. Siltation index values at **Swamp Creek site 01** and **Lost Creek site 01** suggest **severe impairment** from sedimentation and non-support of aquatic life uses. The siltation index value at **Sawlog Creek site 01** indicates **moderate impairment**.

Large percentages of teratological diatom cells (>10%) indicate elevated concentrations of heavy metals and **severe impairment** of aquatic life uses at both sites on **Elkhorn Creek**. A smaller percentage of abnormal cells (3-10%) suggest **moderate impairment** from heavy metals at **Lost Creek site 02**. Several other sites supported still smaller percentages of abnormal diatom cells (<3%).

Diatoms were present in all of the samples. Most of the 27 major diatom species are either sensitive to organic pollution or only somewhat tolerant of organic pollution. Only two of the major diatom species are most tolerant of organic pollution.

In general, diatom species richness, diversity, and equitability were excellent. Most sites supported more than 50 species and diversity values greater than 4.00. Ninety species were counted in one sample (LMCHC02) and another site (MCVYC01) had a diversity index of 5.22. These are exceptionally high values for mountain streams. Only one stream (Elkhorn Creek) had diversity values that indicated unusual stress. At only two sites, both on Elkhorn Creek, did the dominant species contribute more than half of the cells to the diatom assemblage.

High diatom diversity in these streams infers the absence of natural stressors, such as steep gradients, fast currents, low light, low nutrients, and/or constant cold temperatures. The predominance of non-motile, free-living taxa relative to attached species implies that most sites have gentle gradients and slow current velocities compared to other mountain streams. This is confirmed by the comparatively low disturbance index at most sites.

Besides the absence of natural stressors, high diatom diversity in these streams also suggests moderate nutrient enrichment (little competition for available nutrients) and complex microhabitats that are more similar to prairie streams. Pollution index values, which indicate the amount of organic loading, are generally low for mountain streams. Many are at or below the threshold for minor impairment. Similarly, siltation index values tend to be higher in Big Hole tributaries than in most mountain streams.

Introduction

This report evaluates the biological integrity[1], support of aquatic life uses, and probable causes of stress or impairment to aquatic communities at 42 sites on 22 streams in the Big Hole River TMDL Planning Area of southwestern Montana. The purpose of this report is to provide information that will help the State of Montana determine whether these streams are water-quality limited and in need of TMDLs.

The federal Clean Water Act directs states to develop water pollution control plans (Total Maximum Daily Loads or TMDLs) that set limits on pollution loading to water-quality limited waters. Water-quality limited waters are lakes and stream segments that do not meet water-quality standards, that is, that do not fully support their beneficial uses. The Clean Water Act and USEPA regulations require each state to (1) identify waters that are water-quality limited, (2) prioritize and target waters for TMDLs, and (3) develop TMDL plans to attain and maintain water-quality standards for all water-quality limited waters.

Evaluation of aquatic life use support in this report is based on the species composition and structure of periphyton (aka benthic algae, phytobenthos) communities at 42 sites on 22 streams that were sampled in the summer of 2003. Periphyton is a diverse assortment of simple photosynthetic organisms called algae that live attached to or in close proximity of the stream bottom. Some algae form long filaments or large gelatinous colonies that are conspicuous to the unaided eye. But most algae, including the ubiquitous diatoms, can be seen and identified only with the aid of a microscope. The periphyton community is a basic biological component of all aquatic ecosystems. Periphyton accounts for much of the primary production and biological diversity in Montana streams (Bahls et al. 1992). Plafkin et al. (1989) and Barbour et al. (1999) list several advantages of using periphyton in biological assessments.

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[1] *Biological integrity* is defined as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region" (Karr and Dudley 1981).

Project Area and Sampling Sites

The project area is located within the Middle Rockies Ecoregion (USEPA 2000). The Big Hole watershed occupies a high mountain basin in the southwestern corner of Montana. The surface geology of the watershed is complex, consisting mostly of Belt Series and Boulder and Idaho Batholith Rocks in the uplands and Tertiary basin fill in the Big Hole Valley (Renfro and Feray 1972). Climax vegetation consists of alpine tundra at the highest elevations, Douglas-fir and subalpine fir forest at intermediate elevations, and mixed grassland/sagebrush steppe in the Big Hole Valley. The main land uses are recreation, logging, ranching, and mining.

Periphyton samples were collected at 42 sites on 22 tributaries of the Big Hole River (Table 1). All sites are in USGS HUC 10020004 and are classified either A-1 or B-1 in the Montana Surface Water Quality Standards depending on whether they are above or below the Butte Water Company intake at Divide, Montana.

Methods

Periphyton samples were collected following standard operating procedures of the MDEQ Planning, Prevention, and Assistance Division. Using appropriate tools, microalgae were scraped, brushed, or sucked from natural substrates in proportion to the importance of those substrates at each study site. Macroalgae were picked by hand in proportion to their abundance at the site. All collections of microalgae and macroalgae were pooled into a common container and preserved with Lugol's (IKI) solution.

The samples were examined to estimate the relative abundance of cells and rank by biovolume of diatoms and genera of soft (non-diatom) algae according to the method described in Bahls (1993). Soft algae were identified using Smith (1950), Prescott (1962, 1978), John et al. (2002), and Wehr and Sheath (2003). These books also served as references on the ecology of the soft algae, along with Palmer (1969, 1977).

After the identification of soft algae, the raw periphyton samples were cleaned of organic matter using sulfuric acid, potassium dichromate, and hydrogen peroxide. Then permanent diatom slides were prepared using Naphrax™, a high refractive index mounting medium, following *Standard Methods for the Examination of Water and Wastewater* (APHA 1998). At least 300 diatom cells (600 valves) were counted at random and identified to species. The following were the main taxonomic references for the diatoms: Krammer and Lange-Bertalot 1986, 1988, 1991a, 1991b; Lange-Bertalot 1993, 2001; Krammer 1997a, 1997b, 2002; Reichardt 1997, 1999. Diatom naming conventions followed those adopted by the Integrated Taxonomic Information System (http://www.itis.usda.gov). Van Dam et al. (1994) was the main ecological reference for the diatoms.

The diatom proportional counts were used to generate an array of diatom association metrics. A metric is a characteristic of the biota that changes in some predictable way with increased human influence (Barbour et al. 1999). Diatoms are particularly useful in generating metrics because there is a wealth of information available in the literature regarding the pollution tolerances and water quality preferences of common diatom species (e.g., Lowe 1974, Beaver 1981, Lange-Bertalot 1996, Van Dam et al. 1994).

Values for selected metrics were compared to biocriteria (numeric thresholds) developed for streams in the Rocky Mountain ecoregions of Montana (Table 2). These criteria are based on metric values measured in least-impaired reference streams (Bahls et al. 1992) and metric values measured in streams that are known to be impaired by various sources and causes of pollution (Bahls 1993). The criteria in Table 2 are valid only for samples collected during the summer field season (June 21-September 21) and distinguish among four levels of stress or impairment and three levels of aquatic life use support: (1) no impairment or only minor impairment (full support); (2) moderate impairment (partial support); and (3) severe impairment (nonsupport). These impairment levels correspond to excellent, good, fair, and poor biological integrity, respectively. In cold, high-gradient mountain streams, natural stressors will often mimic the effects of man-caused impairment on some metric values.

Quality Assurance

Several steps were taken to assure that the study results are accurate and reproducible. Upon receipt of the samples, station and sample attribute data were recorded in the Montana Diatom Database and the samples were assigned a unique number, e.g., 2960-01. The first part of this number (2960) designates the sampling site (Doolittle Creek below North Fork) and the second part (01) designates the number of periphyton samples that that have been collected at this site for which data have been entered into the Montana Diatom Database.

Sample observations and analyses of soft (non-diatom) algae were recorded in a lab notebook along with information on the sample label. A portion of the raw sample was used to make duplicate diatom slides. The slides used for the diatom proportional counts will be deposited in the Montana Diatom Collection at the University of Montana Herbarium (MONTU) in Missoula. Duplicate slides will be retained by *Hannaea* in Helena. Diatom proportional counts have been entered into the Montana Diatom Database.

Results and Discussion

Results are presented in Tables 3, 4, 5, and 6 which are located near the end of this report following the references section. Appendix A contains a diatom report for each sample. Each diatom report includes an alphabetical list of diatom species in that sample and their percent abundances, and values for 65 different diatom metrics and ecological attributes.

Sample Notes (Table 3)

Notes on the contents and condition of each sample are recorded in Table 3. Most samples contained varying amounts of sediment and plant material other than algae.

Non-Diatom Algae (Table 4)

Thirty-four genera representing five divisions of non-diatom algae were found in samples that were collected from tributaries of the Big Hole River (Table 4). Divisions represented by the most genera were Chlorophyta or green algae (18 genera) and Cyanophyta or cyanobacteria (11 genera). The Division Chrysophyta (yellow-green algae) was represented by three genera and the Divisions Rhodophyta (red algae) and Euglenophyta (euglenoid algae) were represented by one genus each.

Green algae were found in all but 10 samples and cyanobacteria were found in all but 12 samples. Yellow-green algae were found in 15 samples and the red alga *Audouinella* was found in 10 samples. *Euglena*, a pollution tolerant euglenoid alga, was found in only one sample (DIVDC01). The number of genera of non-diatom algae ranged from 0 in Soap Creek (01) and Lost Creek (02) to 11 in the North Fork of the Big Hole River.

Nitrogen-fixing Algae. Cyanobacteria that possess a certain type of specialized cell (heterocyst) are capable of fixing molecular or atmospheric nitrogen under aerobic conditions. These algae have a competitive advantage in waters where nitrogen is in short supply relative to phosphorus and other nutrients. Among tributaries of the Big Hole River, algae with heterocysts include *Anabaena, Calothrix, Nodularia, Nostoc,* and *Tolypothrix*. Sites where one or more of these genera were common, frequent, or abundant are: DOLTC01, SWMPC01, WRMSC01, WRMSC02, PINEC01 and 02, FOXC01 and 02, FSHTC02, ELKHC01 and 02, and DIVDC02. Nitrogen is most likely the limiting nutrient at these sites.

Mat-forming Filamentous Algae. Large standing crops of filamentous algae can interfere with swimming, boating, fishing, and other water uses. Algal genera in tributaries of the Big Hole River that are known to produce nuisance growths in North American waters are *Cladophora, Oedogonium, Oscillatoria, Spirogyra, Stigeoclonium,* and *Ulothrix* (Wehr and Sheath 2003). Sites where one or more of these genera were dominant or abundant in periphyton samples are: BGHNF01 and 02, JERRC01, LMCHC02, FRANC02, and DIVDC01. Among sites in this sample set, these are the sites that are most likely to support nuisance growths of filamentous algae.

Pollution-tolerant Algae. Palmer (1969) listed 60 algal genera that are most tolerant of organic pollution. Genera of non-diatom algae in this sample set that are among the top 21 on Palmer's list are *Euglena* (#1), *Oscillatoria* (#2), *Scenedesmus* (#4), *Stigeoclonium* (#8), *Ankistrodesmus* (#10), *Phormidium* (#12) *Closterium* (#16), and *Spirogyra* (#21). *Euglena* was found in only one sample (DIVDC01), where it was rare. Sites where one or more of the remaining genera were frequent, abundant, or dominant are: WRMSC02, BGHNF01 and 02, JERRC01, PINEC02, FOXC02, LMCHC02, ELKHC02, and DIVDC01. These sites are the ones that most likely receive the heaviest loads of organic pollution. Genera among the 21 most pollution-tolerant algae were common at several more sites.

Other Indicator Algae. When abundant, certain genera of algae can provide useful clues about environmental conditions. The three genera of chrysophytes that were present in these samples are all good indicator algae. *Tribonema*, which is sensitive to organic pollution and prefers cool waters, was most abundant in Fishtrap Creek. *Vaucheria*, another chrysophyte, requires steady flows of cool water. *Vaucheria* was also abundant in Fishtrap Creek. A third chrysophyte—*Hydrurus foetidus*—is a cold-water stenotherm that requires waters of constant low temperature. *Hydrurus* was found only in upper Gold Creek, where it was abundant.

Draparnaldia is a relatively rare filamentous green alga that is most often found in pristine upland streams and springs. It also tends to be more abundant in cooler waters (Wehr and Sheath 2003). *Draparnaldia* was found only at PINEC01, where it was abundant.

The filamentous green alga *Mougeotia* has often been reported to increase in abundance in lakes that are subject to atmospheric deposition and undergoing acidification. Among study sites in the Big Hole TMDL planning area, *Mougeotia* occurred infrequently and was abundant only at the lower site on Elkhorn Creek (ELKHC02).

The foliose, seaweed-like green alga *Prasiola* has been reported as abundant at sites that are enriched with forms of organic nitrogen, such as bird droppings, as well as in cold mountain streams (Wehr and Sheath 2003). *Prasiola* was found only at the upper site on Gold Creek, where it was dominant.

Diatoms (Table 5)

Diatoms were present in all of the samples. Most of the 27 major diatom species in tributaries of the Big Hole River are either sensitive to organic pollution or only somewhat tolerant of organic pollution. Only two of the major diatom species (*Navicula minima* and *Nitzschia palea*) are most tolerant of organic pollution (Table 5).

In general, diatom species richness, diversity, and equitability were excellent. Most sites supported more than 50 species and diversity values in excess of 4.00. One site (LMCHC02) had 90 species and another (MCVYC01) had a diversity index of 5.22. These are exceptionally high values for mountain streams. Only one stream (Elkhorn Creek) had diversity values that indicated unusual stress. At only two sites, both on Elkhorn Creek, did the dominant species contribute more than half of the cells to the diatom assemblage (Table 5).

High diatom diversity in these streams infers the absence of natural stressors, such as steep gradients, fast currents, low light, low nutrients, and constant cold temperatures. The predominance of non-motile, free-living taxa (*Diatoma mesodon, Fragilaria* spp., *Melosira varians, Meridion circulare, Pseudostarosira brievistriata, Staurosira construens, Staurosirella* spp., *Synedra ulna*) relative to attached species (*Achnanthidium* spp., *Cocconeis placentula*) implies that most sites have gentle gradients and slow current velocities compared to other mountain streams. This is confirmed by the comparatively low disturbance index at most sites (Table 5).

Besides the absence of natural stressors, high diatom diversity in these streams also suggests moderate nutrient enrichment (little competition for available nutrients) and complex microhabitats that are more similar to prairie streams. Pollution index values, which indicate the amount of organic loading, are generally low for mountain streams. Many are at or below the threshold for minor impairment. Similarly, siltation index values tend to be higher in Big Hole tributaries than in most mountain streams.

Many of the sites supported teratological (deformed or physically abnormal) diatom cells. In large numbers, abnormal cells may indicate metals toxicity. The percentage of abnormal cells was within acceptable limits in all streams except Elkhorn Creek and Lost Creek (Table 5).

Similarity index values indicate that ecological changes between adjacent sites on the same stream varied from un-measurable (>60%) to minor (40-60%) to moderate (20-40%). The similarity index ("percent community similarity") measures the cumulative percentage of cells of each taxon that are shared by two stream sites. If diatom metrics indicate that the upstream site has no impairment or only minor impairment, then the similarity index can be used to estimate the degree of impairment that may or may not occur at downstream sites on the same stream.

The diatom order Rhopalodiales includes genera (*Epithemia* and *Rhopalodia*) that are known to harbor nitrogen-fixing endosymbionts within their cells. These symbiotic nitrogen-fixers are single-celled cyanobacteria (blue-green algae). Nitrogen is likely the limiting nutrient in waters that support large numbers of diatoms in the order Rhopalodiales. Among tributaries to the Big Hole River, diatoms in the order Rhopalodiales accounted for more than 2% of the cells at the following sites: FRANC02 (25.39%), DIVD01 (3.46%), DIVD02 (3.24%), MCVYC01 (2.73%), and CAMPC03 (2.05%).

The following paragraphs highlight the key findings for each stream and each site based upon the major diatom species and core diatom metrics in Table 5.

Doolittle Creek. Aside from a few teratological diatom cells, both sites on Doolittle Creek had excellent biological integrity. However, values for both the pollution index and the sedimentation index approached (but did not exceed) the threshold for minor impairment at the downstream site (Table 5). The two sites shared 56% of their diatom assemblages. This indicates that only minor floristic and ecological change occurred between them. The dominant diatom species at the upstream site (*Diatoma mesodon*) indicates consistently cold water.

McVey Creek. Diatom metrics indicate minor impairment from organic loading and sedimentation at site 01. An abundance of *Staurosira construens* and *Pseudostaurosira brevistriata* at site 02 indicates gentle gradients and very little physical disturbance. Both sites supported a few teratological diatom cells. The two sites shared less than 40% of their diatom floras, which indicates a moderate change in environmental conditions.

Swamp Creek. Diatom metrics suggest moderate impairment from organic loading and **severe impairment from sedimentation** at site 01 on Swamp Creek. Cells of the motile genera *Navicula* and *Nitzschia* accounted for three-quarters of the diatoms in the sample from site 01. One of the major species was *Nitzschia palea*, a nitrogen heterotroph that is very tolerant of organic pollution. Conditions were somewhat better at site 02, where diatom metrics indicate only minor impairment from organic loading and sedimentation. However, one of the major species at site 02 was *Navicula minima*, which is also very tolerant of organic enrichment. Both sites had a few abnormal diatom cells and shared only about one-third of their assemblages.

Warm Springs Creek. Site 01 on Warm Springs Creek supported a large number of *Navicula minima*, an eutraphentic nitrogen heterotroph. This resulted in a depressed pollution index that suggests minor impairment from organic loading. Elevated percentages of motile diatoms suggest minor impairment from sedimentation at both sites. A larger percentage of *Achnanthidium minutissimum* suggests steeper gradients and more physical disturbance at site 02. Both sites supported a few teratological cells and they shared slightly less than half of their diatom assemblages.

North Fork Big Hole River. The pollution index at both sites was close to the threshold for minor impairment from organic loading. Sedimentation was also a minor problem at both sites. Site 02 supported 50% more motile diatoms than site 01 and the siltation index at site 02 approached (but did not exceed) the threshold for moderate impairment. The dominant species at site 02 was a highly motile species of *Nitzschia* (*N. archibaldii*). The other major species here indicate somewhat gentler gradients and slower current velocities than site 01. Both sites had a few abnormal cells and they shared slightly more than half of their diatom assemblages.

Gold Creek. The two sites on Gold Creek had very similar values for most metrics and were virtually indistinguishable in terms of diatom species composition. Both sites had pollution index values that indicate minor organic enrichment and both supported a few abnormal diatom cells. Although the sedimentation index at both sites did not exceed the threshold for minor impairment, both sites supported large numbers of *Planothidium* spp., which is adapted to living attached to sand grains.

Jerry Creek. The one sample from Jerry Creek was dominated by *Fragilaria vaucheriae*, an "increaser" that is found worldwide in disturbed freshwater habitats. The other major species at this site are common pollution-sensitive species and indicate gentle gradients and slow current velocities. The pollution index at this site approached but did not exceed the criterion for minor impairment. A few teratological cells were found here.

Pine Creek. Like Gold Creek, the two sites on Pine Creek had similar diatom floras and similar metric values. Both sites had sedimentation index values that barely exceed the threshold for minor impairment. Pollution index values approached, but did not exceed, the threshold for minor impairment. Major diatom species indicate eutrophic waters (enriched with inorganic nutrients) and gentle gradients at both sites. A few abnormal cells were also recorded here.

Fox Creek. Diatom metrics indicate minor impairment from organic loading and sedimentation at both sites on Fox Creek. Major diatom species indicate human disturbance with elevated nutrients at both sites. *Planothidium* species, which are adapted to living attached to sand grains, was a major taxon at site 01. A few deformed cells were counted at site 02 and the two sites shared 54% of their diatom floras.

Fishtrap Creek. The pollution index indicated minor impairment from organic loading at site 01 and borderline impairment at site 02. The siltation index indicated minor impairment from sedimentation at site 02. Major diatom species indicate gentle gradients at both sites and human disturbance with elevated nutrients, especially at site 01. A few abnormal cells were counted at site 01. The diatom floras at the two sites were virtually indistinguishable.

LaMarche Creek. Except for several abnormal cells at site 02, both sites had excellent biological integrity. Diatom species richness, diversity, and equitability were outstanding. Both sites supported more than 80 species (90 species at site 02!) and produced Shannon diversity values greater than 5. Among the major species in LaMarche Creek was *Aulacoseira alpigena*, a planktonic species. The headwaters of LaMarche Creek drain several lakes and ponds in the Anaconda Pintler Wilderness. These waters are the likely source of *A. alpigena* in LaMarche Creek and the main reason for the unusually high species richness and diversity here. The two sites shared slightly more than half of their diatom floras.

Delano Creek. Diatom metrics indicate excellent biological integrity and full support of aquatic life uses at sites 01 and 02 on Delano Creek. None of the core metric values exceeded their respective thresholds for minor impairment here. However, an abundance of *Planothidium* species suggests sandy substrates at both sites. Other than *Planothidium*, the major species at sites 01 and 02 were sensitive to pollution and indicate cold temperatures. Based on the larger percentage of attached diatoms (*Achnanthidium* and *Cocconeis*), sites 01 and 02 appear to have steeper gradients and faster currents than most of the other sites in the sample set. The diatom assemblages at sites 01 and 02 were virtually identical.

The pollution index indicated minor impairment from organic enrichment at site 03. The composition of the diatom assemblage here was quite different from sites 01 and 02. Site 03 supported large numbers of unattached diatoms (*Fragilaria* and *Synedra*) and fewer attached species, which indicates more gentle gradients and slower current velocities. Although an abundance of *Diatoma mesodon* and *Meridion circulare* indicate a continuation of cool water temperatures here, site 03 also supported major species that indicate human disturbance with elevated sediment (*Planothidium* spp.) and inorganic nutrients (*Synedra ulna*). *Fragilaria nitzschioides* was also a major species at site 03. This rather uncommon pollution sensitive species seems to prefer slightly dystrophic waters of low mineral content. No abnormal diatom cells were observed at site 03, which shared less than half of its diatom assemblage with site 02.

Charcoal Gulch. Diatom metrics indicate minor impairment from sedimentation and organic loading at this site. The dominant diatom species here (*Planothidium*) are adapted to

living on sand grains and collectively they indicate a sandy substrate. The other major species—*Nitzschia linearis* and *Synedra ulna*—indicate human disturbance and eutrophication. *Nitzschia linearis* is highly motile and adapted to living on shifting substrates. Charcoal Gulch did not support any teratological diatom cells.

Elkhorn Creek. Large percentages of abnormal diatom cells (>10%) suggest **severe impairment from toxic metals** at both sites on Elkhorn Creek. Moreover, diatom species diversity at these sites was significantly lower than all of the other sites in the sample set. Both sites were dominated by *Achnanthidium minutissimum*. This species tolerates elevated concentrations of heavy metals and, when present in large numbers, indicates probable physical, chemical, and/or biological disturbance. Two pollution-tolerant species of *Fragilaria* were also among the major species at site 02. Sites 01 and 02 were virtually identical, floristically.

Francis Creek. Diatom metrics indicate minor impairment from sedimentation at both sites and minor impairment from organic loading at site 01. This organic loading may be natural in origin. Major species at site 01 show the influence of upstream lakes or ponds (*Aulacoseira alpigena*), elevated inorganic nutrients (*Melosira varians*), sandy substrates (*Planothidium* spp.), and low current velocities (*Staurosira construens*). An abundance of unattached diatoms (*Pseudostaurosira brevistriata, Staurosira construens*) also indicates a gentle gradient at site 02. The other major species at site 02 (*Epithemia sorex*) is a nitrogen fixer and indicates low ambient concentrations of biologically available nitrogen. Abnormal diatom cells were not observed at either site. The two sites shared less than one-third of their diatom assemblages, indicating that a moderate amount of environmental changes occurred between them.

Divide Creek. Minor organic loading and minor, approaching moderate sedimentation was indicated at site 01 on Divide Creek. The major diatom species here indicate alkaline and eutrophic waters. Although no impairment was noted at site 02, both the pollution index and the siltation index approached their respective thresholds for minor impairment. The appearance of *Planothidium* species and *Cocconeis placentula* among the major species at site 02 suggests the presence of sandy substrates. No abnormal diatom cells were observed at either site. They shared less than half of their diatom assemblages.

Soap Creek. Minor impairment from sedimentation was indicated at both sites on Soap Creek. *Planothidium* species were dominant at both sites. Minor impairment from organic loading was indicated at site 01 and borderline impairment from organic loading was noted at site 02. Major diatom species indicate slower current velocities at site 01 and more physical disturbance at site 02. Abnormal cells were not observed at either site and the two sites supported very similar diatom floras.

MacLean Creek. Diatom metrics indicate minor impairment from sedimentation and organic loading in MacLean Creek. The dominant diatom species at this site (*Planothidium lanceolatum*) is adapted to living attached to grains of sand. Another major species at this site (*Nitzschia linearis*) is highly motile and adapted to living on shifting substrates composed of fine sediments. A few abnormal diatom cells were observed in the sample from MacLean Creek.

Grose Creek. Diatom metrics indicate minor impairment from organic loading and **borderline moderate impairment from sedimentation** in Grose Creek. *Planothidium* species dominated the diatom assemblage of Grose Creek, as they did in MacLean Creek. *Nitzschia linearis* was also a major species in Grose Creek. No abnormal diatom cells were observed in the sample from Grose Creek.

Lost Creek. A large number of highly motile diatoms indicates **severe impairment from sedimentation** at site 01 on Lost Creek. In addition, the pollution index value at site 01 approached the criterion for moderate impairment from organic loading. The dominant species here was *Nitzschia inconspicua*. Besides being highly motile, this species is eutraphentic and a facultative nitrogen heterotroph. *Navicula minima* was another major species at site 01. This species is also a motile, eutraphentic, nitrogen heterotroph. A few abnormal cells were observed in the sample collected at site 01.

Much less organic loading and sedimentation were observed at site 02, where the pollution index indicated no impairment and the sedimentation index indicated only minor impairment. *Cocconeis placentula, Planothidium* species, and *Rhoicosphenia abbreviata*

replaced *Nitzschia inconspicua* and *Navicula minima* as major species at site 02. The first two indicate the presence of sandy substrates at site 02. All three species tolerate eutrophic conditions but much less organic loading than *N. inconspicua* and *N. minima*. Site 02 did support 3.88% abnormal diatom cells, which suggests **moderate impairment from elevated heavy metals**. The two sites on Lost Creek shared only about one-third of their diatom floras.

Sawlog Creek. Diatom metrics suggest **moderate impairment from sedimentation** and minor impairment from organic loading at site 01 on Sawlog Creek. This was one of the few sites where motile *Navicula* species (*N. capitatoradiata* and *N. reichardtiana*) were abundant. Like these *Naviculas,* the other major species here (*Encyonema silesiacum* and *Planothidium* species) are also eutraphentic and somewhat tolerant of organic enrichment.

Diatom metrics at site 02 on Sawlog Creek indicate somewhat less organic loading and sedimentation than site 01, but still within the range of minor impairment. In addition to the eutraphentic *Encyonema silesiacum*, the major species at site 02 indicate elevated inorganic nutrients (*Synedra ulna*) and slower current velocities (*Staurosira construens*). No abnormal diatom cells were observed at either site 01 or site 02, which shared about half of their diatom assemblages.

Camp Creek. All three sites on Camp Creek suffered minor impairment from sedimentation, which approached **moderate impairment** at sites 02 and 03. *Planothidium* species and the highly motile *Nitzschia linearis* were among the major species at sites 02 and 03, but not at 01. The dominant diatom at site 01 was the attached and pollution sensitive species *Achnanthidium affine*. Organic loading was also a minor problem at site 02. The pollution index at sites 01 and 03 approached but did not exceed the threshold for minor impairment. Abnormal diatom cells were not observed in any of the Camp Creek samples. Sites 01 and 02 were very different from one another, floristically, sharing only about one-quarter of their diatom floras. Sites 02 and 03 were nearly as different and shared only about one-third of their assemblages.

Modal Categories (Table 6)

Several ecological attributes assigned by Stevenson and Van Dam et al. (1994) were selected from the diatom reports in the appendix and modal categories of these attributes were extracted to characterize water quality tendencies in tributaries of the Big Hole River (Table 6).

The majority of diatoms at most sites in the Big Hole TMDL planning area were non-motile, alkaliphilous, nitrogen autotrophs that prefer fresh waters, moderate BOD levels, high oxygen levels, and eutrophic conditions or variable levels of inorganic nutrients. However, the modal categories at some sites represent significant departures in water quality when compared to most other sites in the sample set. These departures, which may reflect increases or decreases in water quality, are discussed below.

Although most of the sites were dominated by non-motile diatoms, SWMPC01 and LOSTC01 were dominated by highly motile diatoms and SWLGC01 was dominated by moderately motile diatoms. These are the sites that are most likely to have sedimentation problems.

Diatom species that prefer circumneutral (as opposed to alkaline) pH values were most abundant at SWMPC01, LMCHC01, and ELKHC01 and 02. These sites are likely to have lower pH values than the remaining sites.

Nitrogen autotrophs were in the majority at all sites except LOSTC01 and CAMPC01. At site 01 on Lost Creek, facultative heterotrophs (mainly *Navicula minima* and *Nitzschia inconspicua*) accounted for the majority of the diatom cells. This site likely receives heavier loads of organic nitrogen than other sites in the sample set. At site 01 on Camp Creek, most cells were represented by species that have not been classified with regard to nitrogen uptake (e.g., *Achnanthidium affine*).

The modal category for oxygen demand was less than "continuously high" at several sites. Most diatoms were in the "fairly high" category at SWMPC01 and DIVDC01 and 02.

Moderate oxygen demand was the modal category at MCVYC01, SWMPC02, GOLDC02, FOXC02, DLNOC01 and 03, CHRGC01, CAMPC02 and 03, and at all stations in Soap Creek, MacLean Creek, Grose Creek, Lost Creek, and Sawlog Creek. At site 01 on Camp Creek, most cells were represented by species that have not been classified with regard to oxygen demand (e.g., *Achnanthidium affine*).

Beta-mesosaprobous was the usual level of saprobity at most sites. This represents a dissolved oxygen saturation level of 70-85% and 2-4 mg/L of biochemical oxygen demand (BOD_5). But saprobity levels were higher or lower than this level at some sites. Sites where most of the diatoms indicated **more** organic loading (alpha-mesosaprobous) were GOLDC02, CHRGC01, FRANC01, MCLNC01, LOSTC01, and SWLGC01. The alpha-mesosaprobous level corresponds to 25-70% saturation of dissolved oxygen and 4-13 mg/L BOD_5. Sites where most of the diatoms indicated **less** organic loading than usual (oligosaprobous) were DOLTC01, GOLDC01, both sites on LaMarche Creek, and CAMPC01. The oligosaprobous category corresponds to >85% oxygen saturation and <2 mg/L BOD_5.

At two sites the majority of diatoms represented species that prefer **lower** concentrations of inorganic nutrients than indicated at most of the other sites. Site 01 on LaMarche Creek (LMCHC01) was dominated by oligotraphentic diatom species (e.g., *Aulacoseira alpigena*). Oligotraphentic is the lowest (least enriched) nutrient category. Site 02 on McVey Creek (MCVYC02) was dominated by meso-eutraphentic species (e.g., *Staurosira construens*). Meso-eutraphentic is the next level below (less enriched than) eutraphentic.

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Table 1. Location of MDEQ periphyton sampling stations in the Big Hole River TMDL Planning Area in 2003.

Station	Montana DEQ Station Code	*Hannaea* Sample Number	Latitude	Longitude	Sample Date
Doolittle Creek at gage below N. F. Doolittle Cr.	M03DOLTC01	2960-01	45 43 04	113 20 43	6/19/03
Doolittle Creek above Highway 43	M03DOLTC02	2961-01	45 44 16	113 22 46	6/19/03
McVey Creek at upper state land boundary	M03MCVYC01	2962-01	45 40 36	113 23 12	6/19/03
McVey Creek above Highway 43	M03MCVYC02	2963-01	45 42 00	113 25 24	6/20/03
Swamp Creek above Highway 43	M03SWMPC01	2964-01	45 37 46	113 30 09	6/20/03
Swamp Creek above lower North Fork Road	M03SWMPC02	2965-01	45 39 32	113 28 11	6/20/03
Warm Springs Creek below Old Tim Creek	M03WRMSC01	2966-01	45 27 16	113 17 58	6/21/03
Warm Springs Creek below Highway 278	M03WRMSC02	2967-01	45 22 05	113 24 48	6/21/03
North Fork Big Hole River at lower N. F. Road	M03BGHNF02	2968-01	45 42 19	113 27 34	7/9/03
North Fork Big Hole River at Big Hole Battlefield	M03BGHNF01	2969-01	45 38 39	113 39 07	7/10/03
Gold Creek above Forest Road 484	M03GOLDC01	2970-01	45 36 56	113 05 03	7/10/03
Gold Creek near mouth	M03GOLDC02	2971-01	45 36 51	113 05 19	7/10/03
Jerry Creek	M03JERRC01	2972-01	45 53 46	112 51 10	7/10/03
Pine Creek above Andrus Creek	M03PINEC02	2973-01	45 14 34	113 20 49	7/15/03
Pine Creek above USFS boundary	M03PINEC01	2974-01	45 12 17	113 20 19	7/15/03
Fox Creek near mouth	M03FOXC02	2975-01	45 16 19	112 21 31	7/15/03
Fox Creek above USFS boundary	M03FOXC01	2976-01	45 14 55	113 16 17	7/15/03
Fishtrap Creek below forks and Swamp Creek	M03FSHTC01	2977-01	45 53 13	113 15 38	7/16/03
Fishtrap Creek below Highway 43	M03FSHTC02	2978-01	45 52 12	113 13 39	7/16/03
LaMarche Creek above USFS boundary	M03LMCHC01	2979-01	45 54 39	113 13 02	7/16/03
LaMarche Creek below Highway 43	M03LMCHC02	2980-01	45 52 42	113 11 55	7/16/03
Delano Creek near mouth	M03DLNOC02	2981-01	45 54 20	112 51 21	7/17/03
Delano Creek 50 yards below M03DLNOC02	M03DLNOC03	2982-01	45 54 18	112 51 21	7/17/03
Delano Creek above Forest Road 83	M03DLNOC01	2983-01	45 54 39	112 51 58	7/17/03
Charcoal Gulch Creek near mouth	M03CHRGC01	2984-01	45 46 57	112 47 15	7/23/03
Elkhorn Creek below Coolidge	M03ELKHC01	2985-01	45 30 01	113 02 38	7/23/03
Elkhorn Creek near mouth	M03ELKHC02	2986-01	45 31 38	113 03 41	7/23/03
Francis Creek below Sand Creek	M03FRANC01	2987-01	45 33 52	113 24 45	7/24/03
Francis Creek above Sanley Creek	M03FRANC02	2988-01	45 35 46	113 26 17	7/24/03
Divide Creek below I-15 Exit 111 at Freely	M03DIVDC01	2989-01	45 51 31	112 40 28	7/30/03
Divide Creek above Highway 43	M03DIVDC02	2990-01	45 45 04	112 44 55	7/30/03

Table 1. Location of MDEQ periphyton sampling stations in the Big Hole River TMDL Planning Area in 2003 (concluded).

Station	Montana DEQ Station Code	*Hannaea* Sample Number	Latitude	Longitude	Sample Date
Soap Creek above Left Fork Soap Creek	M03SOAPC01	2991-01	45 42 13	112 34 14	7/30/03
Soap Creek above Highway 15	M03SOAPC02	2992-01	45 41 13	112 39 02	7/30/03
MacLean Creek near mouth	M03MCLNC01	2993-01	45 44 29	112 40 07	7/31/03
Grose Creek above county road	M03GROSC01	2994-01	45 32 54	112 43 41	9/12/03
Lost Creek 1 mile west of I-15	M03LOSTC01	2995-01	45 29 42	112 44 09	9/13/03
Lost Creek 4 miles from county road	M03LOSTC02	2996-01	45 29 29	112 46 41	9/14/03
Sawlog Creek near mouth	M03SWLGC01	2997-01	45 50 16	113 15 00	9/13/03
Sawlog Creek at end of 4WD road	M03SWLGC02	2998-01	45 49 05	113 13 13	9/13/03
Camp Creek near mouth	M03CAMPC01	2999-01	45 37 31	112 41 11	9/14/03
Camp Creek 2 miles east of I-15	M03CAMPC02	3000-01	45 38 51	112 38 09	9/15/03
Camp Creek above Wickup Creek	M03CAMPC03	3001-01	45 41 57	112 31 58	9/15/03

Table 2. Diatom association metrics used by the State of Montana to evaluate biological integrity in **mountain** streams: references, range of values, expected response to increasing impairment or natural stress, and criteria for rating levels of biological integrity. The lowest rating for any one metric is the rating for that site.

Biological Integrity/ Impairment or Stress/ Use Support	No. of Species Counted[1]	Diversity Index[2] (Shannon)	Pollution Index[3]	Siltation Index[4]	Disturbance Index[5]	% Dominant Species[6]	% Abnormal Cells[7]	Similarity Index[8]
Excellent/None Full Support	>29	>2.99	>2.50	<20.0	<25.0	<25.0	0	>59.9
Good/Minor Full Support	20-29	2.00-2.99	2.01-2.50	20.0-39.9	25.0-49.9	25.0-49.9	>0.0, <3.0	40.0-59.9
Fair/Moderate Partial Support	19-10	1.00-1.99	1.50-2.00	40.0-59.9	50.0-74.9	50.0-74.9	3.0-9.9	20.0-39.9
Poor/Severe Nonsupport	<10	<1.00	<1.50	>59.9	>74.9	>74.9	>9.9	<20.0
References	Bahls 1979 Bahls 1993	Bahls 1979	Bahls 1993	Bahls 1993	Barbour et al. 1999	Barbour et al. 1999	McFarland et al. 1997	Whittaker 1952
Range of Values	0-100+	0.00-5.00+	1.00-3.00	0.0-90.0+	0.0-100.0	~5.0-100.0	0.0-30.0+	0.0-100.0
Expected Response	Decrease[9]	Decrease[9]	Decrease	Increase	Increase	Increase	Increase	Decrease

[1]Based on a proportional count of 300 cells (600 valves)

[2]Base 2 [bits] (Weber 1973)

[3]Composite numeric expression of the pollution tolerances assigned by Lange-Bertalot (1979) to the common diatom species

[4]Sum of the percent abundances of all species in the genera *Navicula, Nitzschia* and *Surirella*

[5]Percent abundance of Achnanthidium minutissimum (synonym: *Achnanthes minutissima*)

[6]Percent abundance of the species with the largest number of cells in the proportional count

[7]Cells with an irregular outline or with abnormal ornamentation, or both

[8]Percent Community Similarity (Whittaker 1952)

[9]Species richness and diversity may increase somewhat in mountain streams in response to slight to moderate increases in nutrients or sediment

Table 3. Sample notes for periphyton samples collected in 2003 from the Big Hole River TMDL Planning Area.

Station Code	Notes
M03DOLTC01	Sample mostly moss and rocks; *Anabaena* occurs as isolated trichomes; *Diatoma mesodon* is visually conspicuous
M03DOLTC02	Sample mostly moss; silty; *Ulothrix* filaments intermingled with moss; *Anabaena* has large, oblong akinetes
M03MCVYC01	Sample mostly macrophytes, moss, rocks, and fungal hyphae
M03MCVYC02	None
M03SWMPC01	Sample mostly rocks; silty
M03SWMPC02	Sample contains pebbles; very silty
M03WRMSC01	Sample mostly fine particulate organic matter; *Ulothrix* senescent and in short segments; *Audouinella* senescent
M03WRMSC02	Sample mostly fine particulate organic matter; silty
M03BGHNF02	Sample mostly moss and large mats of *Oscillatoria*
M03BGHNF01	Sample mostly moss; very silty; *Melosira varians* is visually conspicuous
M03GOLDC01	Sample mostly moss and fine particulate organic matter; *Diatoma hiemalis* is visually conspicuous
M03GOLDC02	Sample mostly moss and fine particulate organic matter and silt; *Diatoma hiemalis* is visually conspicuous
M03JERRC01	Sample silty; mostly filamentous algae; *Closterium* cells are very large; *Synedra* sp. is visually conspicuous
M03PINEC02	Sample mostly macrophytes and FPOM; *Nostoc* is large ear-shaped colony; *Tolypothrix* is senescent
M03PINEC01	Sample contains moss; *Nostoc* consists of large ear-shaped and small, round colonies
M03FOXC02	Sample contains macrophytes and pebbles; *Tolypothrix* is partly senescent
M03FOXC01	Sample mostly moss; *Nostoc* present as small, loose colonies; *Tetraspora* is senescent
M03FSHTC01	Sample contains moss and lots of filamentous algae; *Synedra ulna* is visually conspicuous
M03FSHTC02	Sample mostly filamentous algae; *Nostoc* present as loose colonies; *Ulothrix* is senescent; *Synedra ulna* conspicuous
M03LMCHC01	Sample mostly moss; silty
M03LMCHC02	Sample mostly filamentous algae and moss; *Synedra* is visually conspicuous
M03DLNOC02	Sample consists mainly of one big root wad; algae very sparse
M03DLNOC03	Sample mostly filamentous algae
M03DLNOC01	Sample mostly moss
M03CHRGC01	Sample mostly moss, macrophytes, and fine particulate organic matter
M03ELKHC01	Sample very silty; *Ulothrix* has very narrow filaments; most diatoms are very small and some are abnormal
M03ELKHC02	Sample very silty; *Phormidium* has very narrow filaments; diatoms are very small and some are abnormal
M03FRANC01	Sample very silty; composed of plant roots and debris; *Melosira varians* is visually conspicuous
M03FRANC02	Sample very silty; *Epithemia sorex* is visually conspicuous
M03DIVDC01	Sample very silty; contains moss
M03DIVDC02	Sample very silty; contains moss

Table 3. Sample notes for periphyton samples collected in 2003 from the Big Hole River TMDL Planning Area (concluded).

Station Code	Notes
M03SOAPC01	Sample putrid with hydrogen sulfide; contains moss and fine particulate organic matter; most diatoms are empty
M03SOAPC02	Sample mostly rocks, roots, and sand
M03MCLNC01	Sample mostly moss; very silty
M03GROSC01	Sample mostly plant parts; very silty
M03LOSTC01	Sample mostly aspen leaves
M03LOSTC02	Sample mostly aspen leaves and plant bits; silty
M03SWLGC01	Sample contains plant bits; silty
M03SWLGC02	Sample mostly moss; *Synedra* and *Melosira* are visually conspicuous
M03CAMPC01	Sample contains plant bits; very silty
M03CAMPC02	Sample contains plant bits and leaves; silty
M03CAMPC03	Sample contains plant bits; *Closterium* cells are huge

Table 4. Relative abundance of cells and ordinal rank by biovolume of diatoms (Division Bacillariophyta) and genera of non-diatom algae in periphyton samples collected from the Big Hole River TMDL Planning Area in 2003: d = dominant, a = abundant, f = frequent, c = common; o = occasional; r = rare.

Taxa	DOLTC01	DOLTC02	MCVYC01	MCVYC02	SWMPC01	SWMPC02	WRMSC01
Cyanophyta							
Amphithrix	o/5	r/6		f/1			
Anabaena	c/2	o/5			f/2		c/5
Calothrix							o/7
Chamaesiphon	o/4						
Merismopedia							
Nodularia							o/8
Nostoc							
Oscillatoria	c/3			o/3	o/6		c/4
Phormidium							
Symploca							
Tolypothrix							
Rhodophyta							
Audouinella			o/2		o/5	f/2	f/2
Chlorophyta							
Ankistrodesmus							
Cladophora							
Closterium							
Cosmarium					r/7		
Draparnaldia							
Hormidium					o/4		
Microspora							
Mougeotia						o/5	
Oedogonium						c/3	
Pediastrum							
Prasiola							
Scenedesmus						o/6	
Spirogyra							
Staurastrum							
Stigeoclonium		c/3			c/3	c/4	o/6
Tetraspora							
Ulothrix		f/2					c/3
Zygnema							
Euglenophyta							
Euglena							
Chrysophyta							
Hydrurus foetidus							
Tribonema		o/4					
Vaucheria							
Bacillariophyta	f/1	a/1	o/1	c/2	a/1	a/1	a/1
No. Non-Diatom Genera	4	5	1	2	6	5	7

Table 4. Relative abundance of cells and ordinal rank by biovolume of diatoms (Division Bacillariophyta) and genera of non-diatom algae in periphyton samples collected from the Big Hole River TMDL Planning Area in 2003: d = dominant, a = abundant, f = frequent, c = common; o = occasional; r = rare. (continued)

Taxa	WRMSC02	BGHNF01	BGHNF02	GOLDC01	GOLDC02	JERRC01	PINEC01
Cyanophyta							
Amphithrix							
Anabaena	a/1	o/8	o/9				
Calothrix	c/5		o/8				
Chamaesiphon							
Merismopedia							
Nodularia							
Nostoc							f/3
Oscillatoria	f/3	o/9	d/1	o/7			
Phormidium							
Symploca							
Tolypothrix	c/4						o/6
Rhodophyta							
Audouinella	o/7		o/6	o/8			
Chlorophyta							
Ankistrodesmus			o/11				
Cladophora							
Closterium	r/9	o/7	c/5	c/5	c/3	c/4	c/4
Cosmarium	o/8	o/6	o/7		o/4		
Draparnaldia							a/1
Hormidium							
Microspora							
Mougeotia		c/4					
Oedogonium		c/5					
Pediastrum			r/12				
Prasiola				d/1			
Scenedesmus		r/10	o/10				
Spirogyra	o/6	a/2	c/4	o/6		f/3	
Staurastrum		r/11					
Stigeoclonium			f/3				
Tetraspora							c/5
Ulothrix						d/2	
Zygnema						c/6	
Euglenophyta							
Euglena							
Chrysophyta							
Hydrurus foetidus				a/3			
Tribonema		f/3		c/4	c/2	c/5	
Vaucheria							
Bacillariophyta	f/2	d/1	a/2	d/2	a/1	d/1	a/2
No. Non-Diatom Genera	8	10	11	7	3	5	5

Table 4. Relative abundance of cells and ordinal rank by biovolume of diatoms (Division Bacillariophyta) and genera of non-diatom algae in periphyton samples collected from the Big Hole River TMDL Planning Area in 2003: d = dominant, a = abundant, f = frequent, c = common; o = occasional; r = rare. (continued)

Taxa	PINEC02	FOXC01	FOXC02	FSHTC01	FSHTC02	LMCHC01	LMCHC02
Cyanophyta							
Amphithrix							
Anabaena	o/7		o/5	o/7			
Calothrix							
Chamaesiphon							
Merismopedia							r/8
Nodularia							
Nostoc	c/4	f/2	o/4		a/3	o/6	o/7
Oscillatoria	f/2				o/9	c/3	
Phormidium							
Symploca							
Tolypothrix	o/6		c/3				
Rhodophyta							
Audouinella		o/5				o/4	
Chlorophyta							
Ankistrodesmus							
Cladophora							
Closterium	c/3	c/3	f/2	c/5	c/4	o/2	c/6
Cosmarium				o/6	o/8		
Draparnaldia							
Hormidium							
Microspora							
Mougeotia				o/8			
Oedogonium							c/5
Pediastrum							
Prasiola							
Scenedesmus							
Spirogyra					o/6		d/1
Staurastrum	r/8			r/9	r/10		
Stigeoclonium		o/6					
Tetraspora	c/5	c/4					
Ulothrix				c/4	c/5		
Zygnema					o/7		c/4
Euglenophyta							
Euglena							
Chrysophyta							
Hydrurus foetidus							
Tribonema				a/3	d/1	o/5	f/3
Vaucheria				d/1			
Bacillariophyta	a/1	a/1	a/1	d/2	d/2	f/1	a/2
No. Non-Diatom Genera	7	5	4	8	9	5	7

Table 4. Relative abundance of cells and ordinal rank by biovolume of diatoms (Division Bacillariophyta) and genera of non-diatom algae in periphyton samples collected from the Big Hole River TMDL Planning Area in 2003: d = dominant, a = abundant, f = frequent, c = common; o = occasional; r = rare. (continued)

Taxa	DLNOC01	DLNOC02	DLNOC03	CHRGC01	ELKHC01	ELKHC02	FRANC01
Cyanophyta							
Amphithrix							
Anabaena							
Calothrix					c/3	c/3	
Chamaesiphon							
Merismopedia							
Nodularia							
Nostoc							
Oscillatoria	c/2	o/2		o/5		o/6	
Phormidium						f/4	
Symploca							
Tolypothrix							
Rhodophyta							
Audouinella							
Chlorophyta							
Ankistrodesmus							
Cladophora							
Closterium		r/3	o/3	o/3			o/3
Cosmarium						o/5	
Draparnaldia							
Hormidium							
Microspora							
Mougeotia				o/4		a/2	
Oedogonium							
Pediastrum							
Prasiola							
Scenedesmus							
Spirogyra							
Staurastrum							
Stigeoclonium							
Tetraspora							
Ulothrix					f/2		
Zygnema			d/1				
Euglenophyta							
Euglena							
Chrysophyta							
Hydrurus foetidus							
Tribonema				o/2			o/2
Vaucheria							
Bacillariophyta	c/1	c/1	c/2	a/1	a/1	a/1	a/1
No. Non-Diatom Genera	1	2	2	4	2	5	2

Table 4. Relative abundance of cells and ordinal rank by biovolume of diatoms (Division Bacillariophyta) and genera of non-diatom algae in periphyton samples collected from the Big Hole River TMDL Planning Area in 2003: d = dominant, a = abundant, f = frequent, c = common; o = occasional; r = rare. (continued)

Taxa	FRANC02	DIVDC01	DIVDC02	SOAPC01	SOAPC02	MCLNC01	GROSC01
Cyanophyta							
Amphithrix			f/3				
Anabaena							
Calothrix						r/2	
Chamaesiphon							
Merismopedia							
Nodularia							
Nostoc			f/2				
Oscillatoria		o/8			r/2		
Phormidium							
Symploca			c/5				
Tolypothrix							
Rhodophyta							
Audouinella							o/2
Chlorophyta							
Ankistrodesmus	c/5	o/9					
Cladophora	d/1						
Closterium	o/3						
Cosmarium		c/5	o/6				
Draparnaldia							
Hormidium							
Microspora							
Mougeotia							
Oedogonium		o/4					
Pediastrum	r/6						
Prasiola							
Scenedesmus	c/4	c/6	o/7				
Spirogyra							
Staurastrum		c/7					
Stigeoclonium		a/2					
Tetraspora							
Ulothrix							
Zygnema							
Euglenophyta							
Euglena		r/10					
Chrysophyta							
Hydrurus foetidus							
Tribonema		f/3	c/4				
Vaucheria							
Bacillariophyta	a/2	d/1	a/1	a/1	f/1	c/1	c/1
No. Non-Diatom Genera	5	9	6	0	1	1	1

Table 4. Relative abundance of cells and ordinal rank by biovolume of diatoms (Division Bacillariophyta) and genera of non-diatom algae in periphyton samples collected from the Big Hole River TMDL Planning Area in 2003: d = dominant, a = abundant, f = frequent, c = common; o = occasional; r = rare. (concluded)

Taxa	LOSTC01	LOSTC02	SWLGC01	SWLGC02	CAMPC01	CAMPC02	CAMPC03
Cyanophyta							
Amphithrix							
Anabaena							
Calothrix							
Chamaesiphon							
Merismopedia							
Nodularia							
Nostoc							
Oscillatoria				o/7	c/2		c/3
Phormidium							
Symploca							
Tolypothrix							
Rhodophyta							
Audouinella							
Chlorophyta							
Ankistrodesmus							
Cladophora							
Closterium				o/5		o/4	c/2
Cosmarium				o/6			
Draparnaldia							
Hormidium							
Microspora						c/3	
Mougeotia							
Oedogonium	o/2			c/4			
Pediastrum							
Prasiola							
Scenedesmus							
Spirogyra				c/3		c/2	
Staurastrum							
Stigeoclonium							
Tetraspora							
Ulothrix							
Zygnema							
Euglenophyta							
Euglena							
Chrysophyta							
Hydrurus foetidus							
Tribonema			o/2	f/2			
Vaucheria							
Bacillariophyta	o/1	c/1	c/1	d/1	a/1	a/1	f/1
No. Non-Diatom Genera	1	0	1	6	1	3	2

Table 5. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from the Big Hole River TMDL Planning Area in 2003. <u>Underlined values</u> indicate minor stress; **bold values** indicate moderate stress; **<u>underlined and bold</u>** values indicate severe stress; all other values indicate no stress and full support of aquatic life uses when compared to biocriteria (thresholds) in Table 2. Observed stress may be natural or anthropogenic.

Species/Metric[2]	DOLTC01	DOLTC02	MCVYC01	MCVYC02	SWMPC01	SWMPC02	WRMSC01
Achnanthidium affine							
Ach. minutissimum							7.54
Aulacoseira alpigena							
Cocconeis placentula							
Diatoma mesodon	18.13						
<u>Encyonema silesiacum</u>							
Epithemia sorex							
<u>Fragilaria capucina</u>							
Fragilaria nitzschioides							
<u>Fragilaria vaucheriae</u>	7.83	9.57	16.02			8.60	
<u>Melosira varians</u>							
Meridion circulare							
<u>Navicula capitatoradiata</u>							
Navicula minima				5.92		9.59	16.72
<u>Navicula reichardtiana</u>							
<u>Nitzschia archibaldii</u>					18.63		
<u>Nitzschia inconspicua</u>						7.76	
<u>Nitzschia linearis</u>							
Nitzschia palea					17.07		
Nitzschia perminuta					9.82		
<u>Planothidium spp.</u>			8.01	5.03		8.74	
Pseudostaur. brevistriata		11.16		19.39			7.40
Rhoicosphenia abbreviata							
Staurosira construens	10.45	10.71		28.90		8.18	8.28
Staurosirella leptostauron							
Staurosirella pinnata		9.11	6.25				
<u>Synedra ulna</u>							
No. of Species Counted	64	59	75	55	67	57	61
Species Diversity	4.84	4.93	5.22	4.03	4.61	4.75	4.79
Pollution Index	2.67	2.54	<u>2.31</u>	2.67	**1.93**	<u>2.23</u>	<u>2.46</u>
Siltation Index	9.83	18.68	<u>25.59</u>	15.44	**<u>75.53</u>**	<u>31.88</u>	<u>27.22</u>
Disturbance Index	3.23	2.28	1.95	0.72	0.43	1.13	7.54
% Dominant Species	18.13	11.16	16.02	<u>28.90</u>	18.63	9.59	16.72
% Abnormal Cells	<u>0.61</u>	<u>0.46</u>	<u>1.37</u>	<u>0.72</u>	<u>0.43</u>	<u>1.27</u>	<u>0.59</u>
Similarity Index[3]	<u>55.84</u>	<u>55.84</u>	**37.69**	**37.69**	**32.32**	**32.32**	<u>45.04</u>

[1]A major diatom species accounts for 9.0% or more of the cells at one or more stations in a sample set. Values for major species are shown only where they equal or exceed 5.0% of the cells in that sample.

[2]Species that are sensitive to organic pollution are in *italics*; species that are somewhat tolerant of organic pollution are <u>underlined</u>; species that are very tolerant to organic pollution are in **bold face type**.

[3]Percent Community Similarity (Whittaker 1952) when compared to the diatom assemblage at the adjacent station on the same stream.

Table 5. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from the Big Hole River TMDL Planning Area in 2003. <u>Underlined values</u> indicate minor stress; **bold values** indicate moderate stress; <u>**underlined and bold**</u> values indicate severe stress; all other values indicate no stress and full support of aquatic life uses when compared to biocriteria (thresholds) in Table 2. Observed stress may be natural or anthropogenic. (continued)

Species/Metric[2]	WRMSC02	BGHNF01	BGHNF02	GOLDC01	GOLDC02	JERRC01	PINEC01
Achnanthidium affine							
Ach. minutissimum	25.30	7.00					
Aulacoseira alpigena							
Cocconeis placentula							
Diatoma mesodon							
<u>Encyonema silesiacum</u>							
Epithemia sorex							
<u>Fragilaria capucina</u>							
Fragilaria nitzschioides							
<u>Fragilaria vaucheriae</u>	6.36			11.96	19.52	25.50	7.36
<u>Melosira varians</u>		8.00					
Meridion circulare							8.59
<u>Navicula capitatoradiata</u>							
Navicula minima							
<u>Navicula reichardtiana</u>							
<u>Nitzschia archibaldii</u>			20.67				6.60
<u>Nitzschia inconspicua</u>							
<u>Nitzschia linearis</u>							
Nitzschia palea							
<u>Planothidium spp.</u>				13.40	12.52		
Pseudostaur. brevistriata	7.81	12.43	18.04	14.19	9.39	7.25	16.41
Rhoicosphenia abbreviata							
Staurosira construens	6.23	9.57	10.85			12.21	12.88
Staurosirella leptostauron				5.10	9.84		
Staurosirella pinnata	6.62	5.00				13.56	
<u>Synedra ulna</u>							
No. of Species Counted	58	64	56	44	49	47	52
Species Diversity	4.44	4.94	4.24	4.27	4.29	3.96	4.52
Pollution Index	2.59	2.52	<u>2.46</u>	<u>2.44</u>	<u>2.44</u>	2.52	2.63
Siltation Index	<u>27.42</u>	<u>23.00</u>	<u>36.66</u>	18.02	16.10	6.04	<u>20.86</u>
Disturbance Index	<u>25.30</u>	7.00	4.55	4.63	2.98	0.54	1.84
% Dominant Species	<u>25.30</u>	12.43	20.67	14.19	19.52	<u>25.50</u>	16.41
% Abnormal Cells	<u>1.32</u>	<u>0.14</u>	<u>0.73</u>	<u>0.64</u>	<u>1.49</u>	<u>1.07</u>	<u>0.46</u>
Similarity Index[3]	<u>45.04</u>	<u>54.35</u>	<u>54.35</u>	71.97	71.97		62.30

[1]A major diatom species accounts for 9.0% or more of the cells at one or more stations in a sample set. Values for major species are shown only where they equal or exceed 5.0% of the cells in that sample.
[2]Species that are sensitive to organic pollution are in *italics*; species that are somewhat tolerant of organic pollution are <u>underlined</u>; species that are very tolerant to organic pollution are in **bold face type**.
[3]Percent Community Similarity (Whittaker 1952) when compared to the diatom assemblage at the adjacent station on the same stream.

Table 5. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from the Big Hole River TMDL Planning Area in 2003. Underlined values indicate minor stress; **bold values** indicate moderate stress; **underlined and bold** values indicate severe stress; all other values indicate no stress and full support of aquatic life uses when compared to biocriteria (thresholds) in Table 2. Observed stress may be natural or anthropogenic. (continued)

Species/Metric[2]	PINEC02	FOXC01	FOXC02	FSHTC01	FSHTC02	LMCHC01	LMCHC02
Achnanthidium affine							
Ach. minutissimum						12.95	7.31
Aulacoseira alpigena						12.13	8.71
Cocconeis placentula			7.79				
Diatoma mesodon							
Encyonema silesiacum							
Epithemia sorex							
Fragilaria capucina				13.11			
Fragilaria nitzschioides							
Fragilaria vaucheriae	6.93	7.15	17.06	9.00	9.82	5.25	12.91
Melosira varians							
Meridion circulare							
Navicula capitatoradiata							
Navicula minima							
Navicula reichardtiana							
Nitzschia archibaldii							
Nitzschia inconspicua							
Nitzschia linearis							
Nitzschia palea							
Planothidium spp.	6.61	6.38					
Pseudostaur. brevistriata	13.39			12.16	16.26		6.22
Rhoicosphenia abbreviata							
Staurosira construens	11.97	18.20	9.12	9.48	9.66	8.69	
Staurosirella leptostauron							
Staurosirella pinnata	10.24						
Synedra ulna		6.53		10.43			12.91
No. of Species Counted	65	48	58	65	71	81	90
Species Diversity	4.63	4.53	4.76	4.69	5.00	5.15	5.05
Pollution Index	2.58	2.48	2.42	2.40	2.51	2.80	2.60
Siltation Index	20.94	20.22	30.15	12.95	21.63	14.26	8.55
Disturbance Index	2.36	0.00	0.29	1.90	2.45	12.95	7.31
% Dominant Species	13.39	18.20	17.06	13.11	16.26	12.95	12.91
% Abnormal Cells	1.26	0.00	0.59	0.79	0.00	0.00	1.56
Similarity Index[3]	62.30	54.39	54.39	64.04	64.04	55.21	55.21

[1]A major diatom species accounts for 9.0% or more of the cells at one or more stations in a sample set. Values for major species are shown only where they equal or exceed 5.0% of the cells in that sample.

[2]Species that are sensitive to organic pollution are in *italics*; species that are somewhat tolerant of organic pollution are underlined; species that are very tolerant to organic pollution are in **bold face type**.

[3]Percent Community Similarity (Whittaker 1952) when compared to the diatom assemblage at the adjacent station on the same stream.

Table 5. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from the Big Hole River TMDL Planning Area in 2003. Underlined values indicate minor stress; **bold values** indicate moderate stress; **underlined and bold** values indicate severe stress; all other values indicate no stress and full support of aquatic life uses when compared to biocriteria (thresholds) in Table 2. Observed stress may be natural or anthropogenic. (continued)

Species/Metric[2]	DLNOC01	DLNOC02	DLNOC03	CHRGC01	ELKHC01	ELKHC02	FRANC01
Achnanthidium affine							
Ach. minutissimum	11.79	13.21			73.66	55.73	
Aulacoseira alpigena							16.98
Cocconeis placentula	13.05	11.32					
Diatoma mesodon	10.53	5.03	8.01				
Encyonema silesiacum							
Epithemia sorex							
Fragilaria capucina						15.54	
Fragilaria nitzschioides			15.23				
Fragilaria vaucheriae						15.86	
Melosira varians							14.31
Meridion circulare		5.35	6.12				
Navicula capitatoradiata							
Navicula minima							
Navicula reichardtiana							
Nitzschia archibaldii							
Nitzschia inconspicua							
Nitzschia linearis				5.61			
Nitzschia palea							
Planothidium spp.	25.31	14.31	6.75	36.21			6.76
Pseudostaur. brevistriata							
Rhoicosphenia abbreviata							
Staurosira construens							5.50
Staurosirella leptostauron							
Staurosirella pinnata							
Synedra ulna			19.31	8.48			
No. of Species Counted	47	52	40	58	49	34	69
Species Diversity	4.19	4.65	4.19	4.20	2.16	2.29	4.79
Pollution Index	2.56	2.61	2.41	2.19	2.87	2.65	2.39
Siltation Index	8.81	14.78	10.05	24.39	1.10	0.47	22.96
Disturbance Index	11.79	13.21	4.87	1.36	**73.66**	**55.73**	0.00
% Dominant Species	19.18	13.21	19.31	34.39	**73.66**	**55.73**	16.98
% Abnormal Cells	0.00	0.00	0.00	0.00	**11.20**	**19.94**	0.00
Similarity Index[3]	66.35		47.44		68.00	68.00	31.25

[1]A major diatom species accounts for 9.0% or more of the cells at one or more stations in a sample set. Values for major species are shown only where they equal or exceed 5.0% of the cells in that sample.
[2]Species that are sensitive to organic pollution are in *italics*; species that are somewhat tolerant of organic pollution are underlined; species that are very tolerant to organic pollution are in **bold face type**.
[3]Percent Community Similarity (Whittaker 1952) when compared to the diatom assemblage at the adjacent station on the same stream.

Table 5. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from the Big Hole River TMDL Planning Area in 2003. <u>Underlined values</u> indicate minor stress; **bold values** indicate moderate stress; **<u>underlined and bold</u>** values indicate severe stress; all other values indicate no stress and full support of aquatic life uses when compared to biocriteria (thresholds) in Table 2. Observed stress may be natural or anthropogenic. (continued)

Species/Metric[2]	FRANC02	DIVDC01	DIVDC02	SOAPC01	SOAPC02	MCLNC01	GROSC01
Achnanthidium affine							
Ach. minutissimum					10.41	7.53	
Aulacoseira alpigena							
Cocconeis placentula			19.11	10.45	11.67	7.83	9.98
Diatoma mesodon							
<u>*Encyonema silesiacum*</u>		5.20					
Epithemia sorex	24.76						
<u>*Fragilaria capucina*</u>							
Fragilaria nitzschioides							
<u>*Fragilaria vaucheriae*</u>							
<u>*Melosira varians*</u>							
Meridion circulare					14.67		8.74
<u>*Navicula capitatoradiata*</u>							
Navicula minima							
<u>*Navicula reichardtiana*</u>							
<u>*Nitzschia archibaldii*</u>							
<u>*Nitzschia inconspicua*</u>							
<u>*Nitzschia linearis*</u>						7.22	6.08
Nitzschia palea							
<u>*Planothidium spp.*</u>			11.64	16.06	16.88	39.78	22.31
Pseudostaur. brevistriata	5.17						
Rhoicosphenia abbreviata		16.85	8.63				
Staurosira construens	26.18		8.01	7.58			
Staurosirella leptostauron							
Staurosirella pinnata							
<u>*Synedra ulna*</u>							
No. of Species Counted	59	68	70	73	50	44	55
Species Diversity	4.01	5.18	4.83	5.20	4.38	3.97	4.76
Pollution Index	2.64	<u>2.30</u>	2.56	<u>2.38</u>	2.54	<u>2.29</u>	<u>2.28</u>
Siltation Index	<u>22.26</u>	<u>34.49</u>	19.72	<u>35.00</u>	<u>23.50</u>	<u>27.34</u>	<u>39.94</u>
Disturbance Index	1.72	0.79	1.23	2.88	10.41	7.53	2.50
% Dominant Species	<u>26.18</u>	16.85	19.11	12.73	15.62	<u>33.95</u>	12.17
% Abnormal Cells	0.00	0.00	0.00	0.00	0.00	<u>0.92</u>	0.00
Similarity Index[3]	**31.25**	<u>46.22</u>	<u>46.22</u>	63.05	63.05		

[1]A major diatom species accounts for 9.0% or more of the cells at one or more stations in a sample set. Values for major species are shown only where they equal or exceed 5.0% of the cells in that sample.

[2]Species that are sensitive to organic pollution are in *italics*; species that are somewhat tolerant of organic pollution are <u>underlined</u>; species that are very tolerant to organic pollution are in **bold face type**.

[3]Percent Community Similarity (Whittaker 1952) when compared to the diatom assemblage at the adjacent station on the same stream.

Table 5. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from the Big Hole River TMDL Planning Area in 2003. <u>Underlined values</u> indicate minor stress; **bold values** indicate moderate stress; **<u>underlined and bold</u>** values indicate severe stress; all other values indicate no stress and full support of aquatic life uses when compared to biocriteria (thresholds) in Table 2. Observed stress may be natural or anthropogenic. (concluded)

Species/Metric[2]	LOSTC01	LOSTC02	SWLGC01	SWLGC02	CAMPC01	CAMPC02	CAMPC03
Achnanthidium affine					36.57		
Ach. minutissimum	21.46	12.73					
Aulacoseira alpigena							
Cocconeis placentula		24.84			6.33		20.79
Diatoma mesodon							
<u>*Encyonema silesiacum*</u>			9.26	14.90			
Epithemia sorex							
<u>*Fragilaria capucina*</u>							
Fragilaria nitzschioides							
<u>*Fragilaria vaucheriae*</u>						7.54	
<u>*Melosira varians*</u>							
Meridion circulare							
<u>*Navicula capitatoradiata*</u>			10.52				
Navicula minima	19.40						
<u>*Navicula reichardtiana*</u>			10.05				
<u>*Nitzschia archibaldii*</u>							
<u>*Nitzschia inconspicua*</u>	30.37						
<u>*Nitzschia linearis*</u>						11.38	6.61
Nitzschia palea							
<u>*Planothidium spp.*</u>		15.06	12.87			18.61	7.24
Pseudostaur. brevistriata							
Rhoicosphenia abbreviata		10.09					
Staurosira construens				9.03			
Staurosirella leptostauron							
Staurosirella pinnata							
<u>*Synedra ulna*</u>				6.34			
No. of Species Counted	39	34	67	75	60	71	79
Species Diversity	3.31	3.87	5.14	5.08	4.05	5.00	4.99
Pollution Index	<u>2.12</u>	2.65	<u>2.22</u>	<u>2.37</u>	2.55	<u>2.29</u>	2.53
Siltation Index	**<u>63.43</u>**	<u>22.98</u>	**46.00**	<u>25.04</u>	<u>24.69</u>	<u>39.08</u>	<u>38.58</u>
Disturbance Index	21.46	12.73	1.73	2.54	0.00	4.46	2.20
% Dominant Species	<u>30.37</u>	24.84	10.52	14.90	<u>36.57</u>	11.38	20.79
% Abnormal Cells	<u>0.32</u>	**3.88**	0.00	0.00	0.00	0.00	0.00
Similarity Index[3]	**34.80**	**34.80**	<u>49.81</u>	<u>49.81</u>	**24.80**		**32.52**

[1]A major diatom species accounts for 9.0% or more of the cells at one or more stations in a sample set. Values for major species are shown only where they equal or exceed 5.0% of the cells in that sample.
[2]Species that are sensitive to organic pollution are in *italics*; species that are somewhat tolerant of organic pollution are <u>underlined</u>; species that are very tolerant to organic pollution are in **bold face type**.
[3]Percent Community Similarity (Whittaker 1952) when compared to the diatom assemblage at the adjacent station on the same stream.

Table 6. Modal categories for selected ecological attributes of diatom species in the Big Hole River TMDL Planning Area. Modal categories that represent significant departures in water quality when compared to most other sites in the sample set are given in **bold** letters.

Ecological	Station						
Attribute	DOLTC01	DOLTC02	MCVYC01	MCVYC02	SWMPC01	SWMPC02	WRMSC01
Motility[1]	not motile	not motile	not motile	not motile	**highly motile**	not motile	not motile
pH[2]	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	**circumneutral**	alkaliphilous	alkaliphilous
Salinity[2]	fresh	fresh	fresh	fresh	fresh	fresh	fresh
Nitrogen Uptake[2]	autotrophs (low organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (low organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (low organics)
Oxygen Demand[2]	continuously high	continuously high	**moderate**	continuously high	**fairly high**	**moderate**	continuously high
Saprobity[2]	**oligo-saprobous**	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous
Trophic State[2]	eutraphentic	variable	eutraphentic	**meso-eutraphentic**	eutraphentic	eutraphentic	variable

[1]Dr. R. Jan Stevenson, Michigan State University, digital communication.
[2]Van Dam et al. 1994

Table 6. Modal categories for selected ecological attributes of diatom species in the Big Hole River TMDL Planning Area. Modal categories that represent significant departures in water quality when compared to most other sites in the sample set are given in **bold** letters. (continued)

Ecological Attribute	Station WRMSC02	BGHNF01	BGHNF02	GOLDC01	GOLDC02	JERRC01	PINEC01
Motility[1]	not motile	not motile	not motile	not motile	not motile	not motile	not motile
pH[2]	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous
Salinity[2]	fresh	fresh	fresh	fresh	fresh	fresh	fresh
Nitrogen Uptake[2]	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (low organics)
Oxygen Demand[2]	continuously high	continuously high	continuously high	continuously high	**moderate**	continuously high	continuously high
Saprobity[2]	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	**oligo-saprobous**	**alpha-meso-saprobous**	beta-meso-saprobous	beta-meso-saprobous
Trophic State[2]	variable	variable	eutraphentic	eutraphentic	eutraphentic	eutraphentic	variable

[1]Dr. R. Jan Stevenson, Michigan State University, digital communication.
[2]Van Dam et al. 1994

Table 6. Modal categories for selected ecological attributes of diatom species in the Big Hole River TMDL Planning Area. Modal categories that represent significant departures in water quality when compared to most other sites in the sample set are given in **bold** letters. (continued)

Ecological	Station						
Attribute	**PINEC02**	**FOXC01**	**FOXC02**	**FSHTC01**	**FSHTC02**	**LMCHC01**	**LMCHC02**
Motility[1]	not motile	not motile	not motile	not motile	not motile	not motile	not motile
pH[2]	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	**circumneutral**	alkaliphilous
Salinity[2]	fresh	fresh	fresh	fresh	fresh	fresh	fresh
Nitrogen Uptake[2]	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (low organics)	autotrophs (high organics)
Oxygen Demand[2]	continuously high	continuously high	**moderate**	continuously high	continuously high	continuously high	continuously high
Saprobity[2]	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	**oligo-saprobous**	**oligo-saprobous**
Trophic State[2]	variable	eutraphentic	eutraphentic	variable	variable	**oligotraphentic**	variable

[1]Dr. R. Jan Stevenson, Michigan State University, digital communication.
[2]Van Dam et al. 1994

Table 6. Modal categories for selected ecological attributes of diatom species in the Big Hole River TMDL Planning Area. Modal categories that represent significant departures in water quality when compared to most other sites in the sample set are given in **bold** letters. (continued)

Ecological	Station						
Attribute	**DLNOC01**	**DLNOC02**	**DLNOC03**	**CHRGC01**	**ELKHC01**	**ELKHC02**	**FRANC01**
Motility[1]	not motile	not motile	not motile	not motile	not motile	not motile	not motile
pH[2]	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	**circumneutral**	**circumneutral**	alkaliphilous
Salinity[2]	fresh	fresh	fresh	fresh	fresh	fresh	fresh
Nitrogen Uptake[2]	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (low organics)
Oxygen Demand[2]	**moderate**	continuously high	**moderate**	**moderate**	continuously high	continuously high	continuously high
Saprobity[2]	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	**alpha-meso-saprobous**	beta-meso-saprobous	beta-meso-saprobous	**alpha-meso-saprobous**
Trophic State[2]	eutraphentic	eutraphentic	variable	eutraphentic	variable	variable	eutraphentic

[1]Dr. R. Jan Stevenson, Michigan State University, digital communication.
[2]Van Dam et al. 1994

Table 6. Modal categories for selected ecological attributes of diatom species in the Big Hole River TMDL Planning Area. Modal categories that represent significant departures in water quality when compared to most other sites in the sample set are given in **bold** letters. (continued)

Ecological	Station						
Attribute	**FRANC02**	**DIVDC01**	**DIVDC02**	**SOAPC01**	**SOAPC02**	**MCLNC01**	**GROSC01**
Motility[1]	not motile	not motile	not motile	not motile	not motile	not motile	not motile
pH[2]	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous
Salinity[2]	fresh	fresh	fresh	fresh	fresh	fresh	fresh
Nitrogen Uptake[2]	autotrophs (low organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)
Oxygen Demand[2]	continuously high	**fairly high**	**fairly high**	**moderate**	**moderate**	**moderate**	**moderate**
Saprobity[2]	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	beta-meso-saprobous	**alpha-meso-saprobous**	beta-meso-saprobous
Trophic State[2]	eutraphentic	eutraphentic	eutraphentic	eutraphentic	eutraphentic	eutraphentic	eutraphentic

[1]Dr. R. Jan Stevenson, Michigan State University, digital communication.
[2]Van Dam et al. 1994

Table 6. Modal categories for selected ecological attributes of diatom species in the Big Hole River TMDL Planning Area. Modal categories that represent significant departures in water quality when compared to most other sites in the sample set are given in **bold** letters. (concluded)

Ecological	Station						
Attribute	LOSTC01	LOSTC02	SWLGC01	SWLGC02	CAMPC01	CAMPC02	CAMPC03
Motility[1]	**highly motile**	not motile	**moderately motile**	not motile	not motile	not motile	not motile
pH[2]	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous	alkaliphilous
Salinity[2]	fresh	fresh	fresh	fresh	fresh	fresh	fresh
Nitrogen Uptake[2]	**facultative heterotrophs**	autotrophs (high organics)	autotrophs (high organics)	autotrophs (high organics)	**not classified**	autotrophs (high organics)	autotrophs (high organics)
Oxygen Demand[2]	moderate	moderate	moderate	moderate	**not classified**	moderate	moderate
Saprobity[2]	**alpha-meso-saprobous**	beta-meso-saprobous	**alpha-meso-saprobous**	beta-meso-saprobous	**oligo-saprobous**	beta-meso-saprobous	beta-meso-saprobous
Trophic State[2]	eutraphentic	eutraphentic	eutraphentic	variable	**not classified**	eutraphentic	eutraphentic

[1]Dr. R. Jan Stevenson, Michigan State University, digital communication.
[2]Van Dam et al. 1994